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## Acute and semi-chronic toxicity of vanadium

*tested on copepods of the species Temora longicornis*

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**Objectives:** This study examines the toxicity and ecological impact of scrubber water on plankton, through acute and chronic toxicity tests, with primarily vanadium. Tests with pH and scrubber water have also been carried out. The study's goal was to: I) find the LC50 of vanadium (single stressor), II) examine how the toxicity of vanadium and scrubber water may change with varying pH (double stressor), III) devise an ecotoxicological assessment on scrubber water handling and disposal (based on empirical data and test results), and IV) to determine the marine environmental impacts scrubber water discharge into the sea may have.

**Background:** Marine scrubber-systems on ships are on the rise, which leads to concerns regarding safe handling of the waste products, namely scrubber water. The most common way of discarding scrubber water is through discharge into the sea where it disperses and dilutes to concentrations that are considered safe. However, in heavily trafficked zones with slow water flow, discharge of scrubber water may happen too frequently potentially resulting in zones with pH fluctuations and higher concentrations of heavy metals. The noticeable heavy metals in scrubber water are nickel, vanadium and lead. While the ecological effects of Ni and Pb have been tested, the effects of V are largely unknown.

**Case presentation:** This case presents copepods that have been grown in captivity but represent wild copepod populations. They have in several tests been exposed to different concentrations of vanadium and scrubber water, along with varying pH values. The general response found in the acute tests was an increased mortality. For the long exposure chronic test, a change in respiration and reproduction were found. In the first experiment vanadium was found to have a LC50 at a concentration of 1 - 2 mg vanadium / L. A vanadium concentration higher than 4 mg / L were found to increase the mortality rate of copepods to 100% within 24 hours. In the second experiment pH and vanadium was tested together as double stressors. When the pH was 6 or below along with a constant vanadium concentration of 1 mg / L, 100% mortality of copepods was observed. At pH 7 a lower LC50 was found and less mortality was observed with increasing pH to 8 (the pH of seawater) where the mortality was about 10%. The third experiment showed the impact of pure scrubber water diluted with seawater. Mixing ratios of 25%, 50% 75% and 100% scrubber water showed that a 100% mortality was achieved at ≥50% scrubber water concentration. At 25% scrubber water concentration a mortality of 80% was observed. The fourth experiment set out to test the toxicity of scrubber water that had been neutralized to the pH of seawater. The samples consisted of 100% scrubber water and pH of 6, 7 and 8. The samples with pH 6 had a 100% mortality and a LC50 was found at pH 7. The samples with pH 8 had a mortality of 20%. The final experiment is a longtime exposure of vanadium (chronic test) at concentrations of 0.1 and 0.5 mg / L (low mortality concentrations). The idea is to measure the respiration along with the reproduction and growth rate over a period of 3 weeks to investigate the sub-lethal effects of a low but chronic exposure to vanadium.